Basic Metal Shop SBU

COURSE # MTL103

Version 1.3

The Fine Print

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Colophon

These materials were created electronically using Microsoft Word®. Art was produced using CorelDraw®, Adobe InDesign®, Adobe Illustrator®, Adobe PhotoShop® and SnagIt® for screen captures. The Arial® family of typefaces is used throughout these materials. Written by Tackett Austin. Updated by Mel Olivares and Aaron Haldiman.

Course Synopsis

In this Safety and Basic Use class (SBU), you will learn to safely use some basic tools in the metal shop area of TechShop. These tools are generally used to cut mild steel and aluminum, although some tools cut other materials as well. You will learn how to use the horizontal Band Saw, the cold saw,
the drill press, the vertical Band Saw, the bench/pedestal grinder, and the disk sander. Upon successful completion of this class you will be able to use all of the tools listed above on your own as a TechShop member.

Time Required: 2 Hours

- **Tools Required**

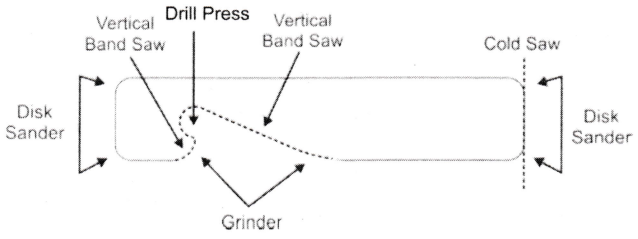
  Horizontal Band Saw
  Cold saw
  Bench/pedestal grinder
  Drill press
  Vertical Band Saw
  Disk sander
  Center punch
  Dykem
  Scribe
  Measuring tape
  1/2" drill bit
  Ball Peen hammer
  Deburring tool
  Template
  8" Bastard file

- **Materials Required**

  1.25" x 1/8" x 25" mild steel strap
  1.25" x 1/8" x 25" aluminum strap

Project Description

The focus of the basic metal shop SBU is on safely using TechShop's tools to work with thicker metals. A result of all the operations you will perform is a simple bottle opener. Every student will alternate making their bottle opener from steel or aluminum in order to understand the differences involved in cutting both materials.



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SAFETY

- **General Safety**

◊ Eye protection is required when working with anything that might get into your eyes, like metal shards, chemicals, and sawdust. Ear protection should also be considered around loud equipment
◊ Closed-toe shoes must be worn at all times
◊ Long sleeved shirts should be worn when working with chemicals, short sleeved shirts should be worn for anything with a rotary motor (saws, mills, lathes, etc.)
◊ Never leave a machine running and unattended

- **Shop Etiquette**

◊ Never talk to anyone while they are working on a piece of equipment
◊ Leave the area you are working in cleaner than when you arrived
◊ Never leave a machine running and unattended
◊ Begin final cleanup and store your project no later than 11:30 pm

- **Equipment Specific Safety**

◊ Do not wear gloves when working with motorized tools in the metal shop
◊ Some of the metal tools are loud, and ear protection is highly recommended
◊ Liquid cooled tools can make slippery puddles on the floor – clean up ASAP
◊ Some tools make hot chips, and makes the part hot as well – give them time to cool off

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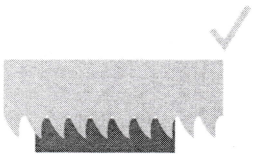
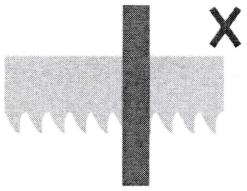
Basic Cutting Theory

With toothed blades, it is important to cut in a way that keeps several teeth (or more) engaged in the metal at the same time. If only a single tooth is cutting, it alone is absorbing the force of the cut and the motor. It will tend to make the blade skip or stall, and quickly breaks teeth off the blade.



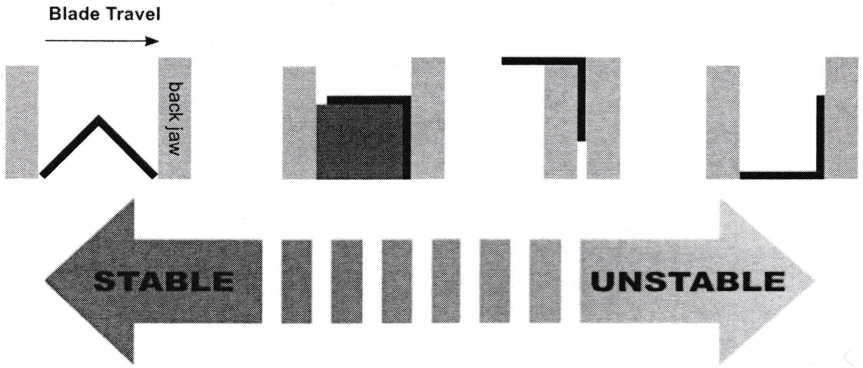
Many teeth engaged in material



Not enough teeth engaged in material

With flat stock, try and cut it horizontally rather than vertically, especially if it is thin. Upright, the stock will catch the teeth and deflect rather than cut. One-eighth-inch-thick stock is the minimum you would cut on this machine; any thinner will be difficult to work hold and should be cut on the hydraulic shear or the vertical Band Saw. The stock will catch the teeth and deflect rather than cut without support and will cause chatter.

When cutting angled stock there are various workholding solutions available. The figure below shows the most stable orientations and the least stable orientations. Unstable orientations can cause your part to move and jam the blade or even throw your part.



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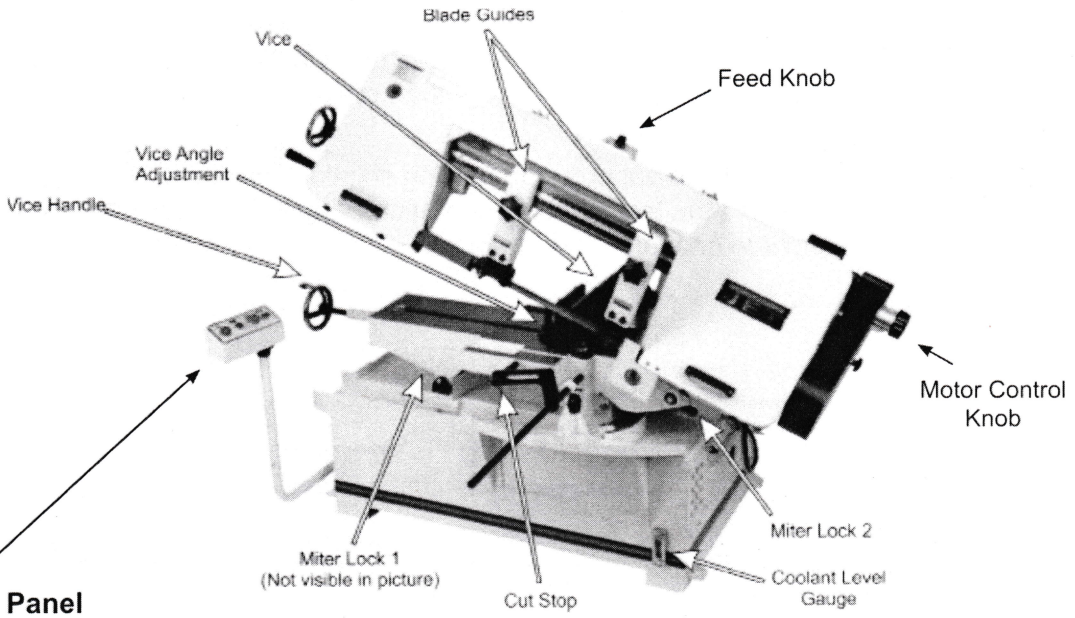
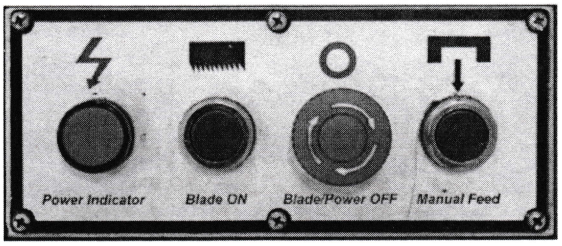
Horizontal Band Saw

The horizontal Band Saw is a liquid cooled, fairly accurate saw capable of cutting mild steel, aluminum and other non-ferrous metals. The horizontal Band Saw is different from a vertical Band Saw in that your material stays stationary while the arm that holds the blade steadily drops down and automatically cuts your metal. At TechShop the saw is hydraulically controlled so you do not need to touch the saw once it is running and coolant is flowing. The saw will automatically finish the cut and turn itself off. Since your work is clamped into a vise, and the blade is steadily dropped, a horizontal Band Saw is capable of making more precise cuts than a vertical Band Saw. However, unlike a vertical Band Saw, you are limited to making straight cuts.





The control panel is the main user interface with the horizontal Band Saw. Members should be able to quickly access it whenever they are making a cut. Never leave the Band Saw while making a cut.

- **Power Indicator:** This red light turns on when the machine is powered and ready to cut.
- **Blade ON:** Press this green button to start the cutting process. It starts both the motor spinning the blade and the pneumatic arm dropping.
- **Blade/Power OFF:** This large red switch stops any cutting processes. When it is pressed, the machine will not engage and the power indicator will turn off. To run the machine twist the button clockwise until it pops out. This will turn on the power indicator signaling the machine is live and ready to cut.
- **Manual Feed:** This button causes the arm of the saw to drop at the speed set on the feed knob WITHOUT running the blade. It is used for positioning the blade above your materials before you cut as well as for lowering the arm into a resting position after you have finished using the machine.

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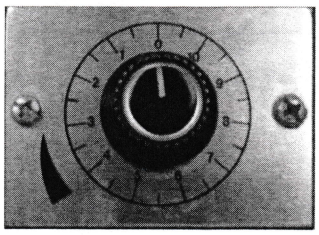
Adjustments

Adjusting feed and speed

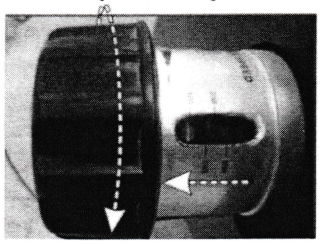
The most important adjustments members make to the horizontal Band Saw is the motor speed at which the blade cuts and the feed speed (drop rate) of the arm. Safe cutting of a material is an appropriate combination of these two movements of the blade. Incorrect settings for your material will crash the machine, break the blade, damage your part, potentially injuring you as well.

Feed Speed Adjustment

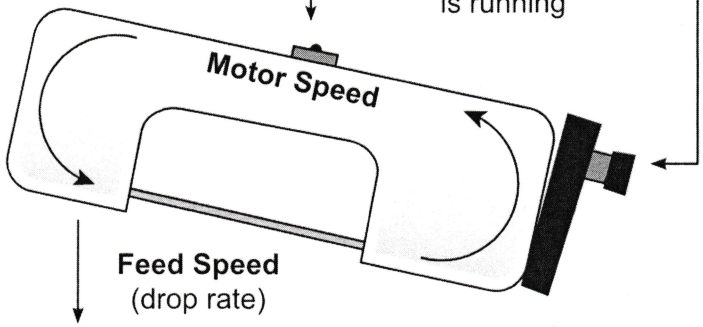


Adjust at any point

Motor Speed Adjustment



Only adjust when motor is running



Speed Chart

Material	Motor Speed	Feed Speed
• Tool Steel • Alloy Steel • Hard Bronze	100	1 - 1.5
• Mild Steel • Brass • Bronze	165	2 -3
• Soft Brass • Hard Aluminum	230	3 - 4
• Aluminum	350	4 - 5

Feed Speed Adjustment

This knob controls how quickly the arm drops. It can be adjusted at any time during the operation. When it is set to zero, the blade will not drop. Use this knob in conjunction with the manual feed button to completely drop the saw when finished using.

Motor Speed Adjustment

This controls how fast the motor rotates the blade. This adjustment can only be made when the motor is running. When changing speeds make sure the red indicator line is pointing towards one of the predefined speed numbers.

Proper Adjustment Sequence

- Raise arm by handle only
- Turn feed speed knob to 0
- Push the green blade on button to start the saw
- Turn the Motor Speed Adjustment knob to the appropriate speed.

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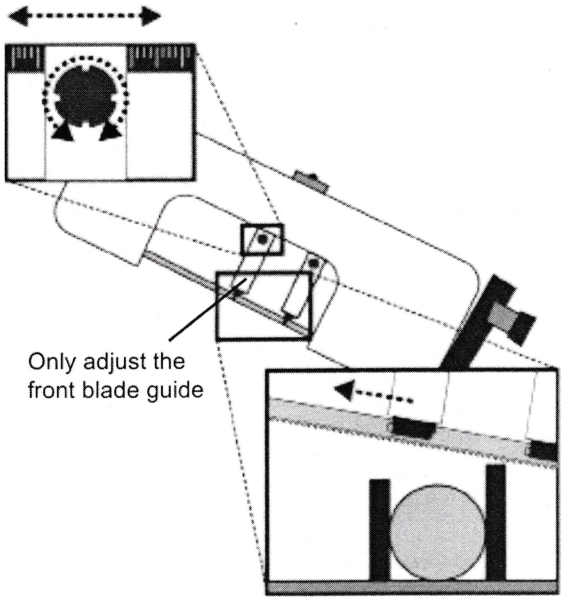
Blade Guide Adjustment

The blade guides should generally not be adjusted. Their purpose is to keep the blade rigid despite the force of the cut.

The only time a member would adjust the guides is when the width of the material exceeds the current cutting area between the guides or during a miter cut. If adjustment is needed, only move the frontal (left) guard arm. NEVER MOVE THE BACK BLADE GUIDE.

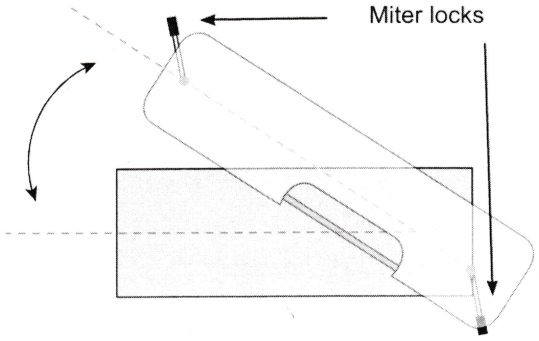
Ideally, you should have 1" of clearance between your material and the frontal blade guide. It is possible for a member to have adjusted this before you and left it, so always check the tolerances at slow feed without the blade running.



Angled Cut Adjustment

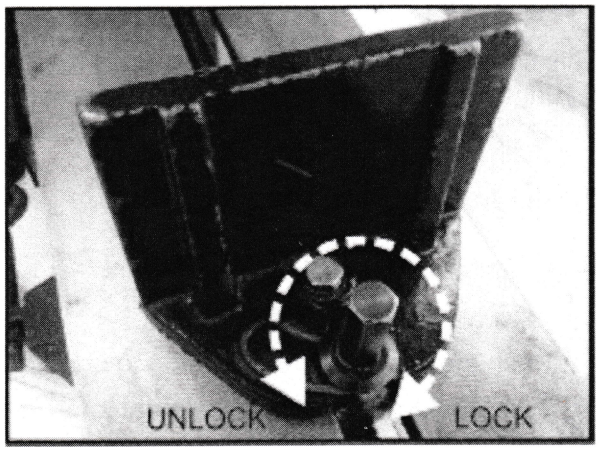
Changing the Blade Angle

1. Loosen both front and back miter locks. When facing each lock pull towards the left to unlock.
2. Move entire carriage by pulling the handle to the left to desired angle. Check angle against gauge.
3. Relock both miter locks.



Changing the Front Vise Angle

1. Loosen the vise angle lock bolt.
2. Turn vise crank handle and clamp onto your part. As the front vise jaw moves towards your material it will automatically align its angle to seat parallel against your part.
3. Tighten the vise angle lock bolt.



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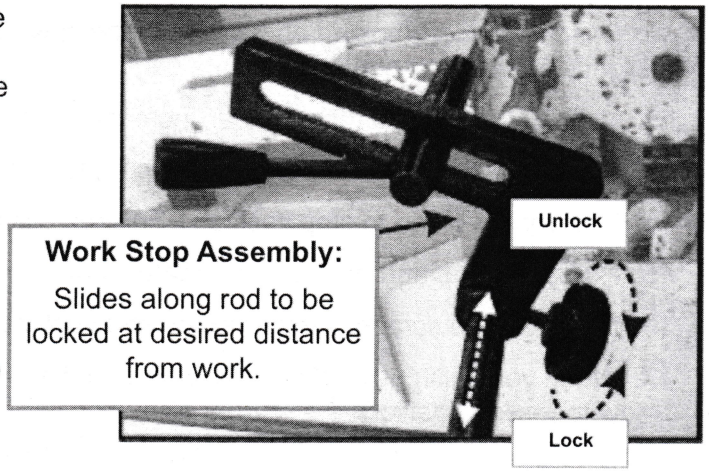
Coolant Flow Adjustment

To protect both the blade and your material from the effects of heating due to the friction of the cut, the horizontal Band Saw has an automatic coolant system. Because of this system, only metals can be cut on this machine. Wood or plastic will ruin the coolant system and make the machine inoperable. To cut wood or plastic use an appropriate vertical Band Saw.

1. At all times coolant must flow during a cut. The entire cutting surface of the blade needs to be covered in coolant.
2. Before making a cut, allow the blade to run for a few seconds with the feed knob set to 0 so the arm does not descend.
3. If there is not a steady flow of coolant, check the red coolant flow lever on top of the arm near the feed speed control knob. Ask a facilities staff member for assistance.

Setting the Work Stop

The work stop is a mechanical stop that can be locked at a specific distance from the vise to allow you to quickly cut many parts of the same length without having to measure every time you cut. Caution: Do not use work stop with angle cuts.



Work Stop Assembly:
Slides along rod to be locked at desired distance from work.

1. Hold part loosely in vise and slowly drop blade to 1/2"above material.
2. Measure and move material until the correct cut length is achieved. Allow for the blade kerf (the thickness of the blade).
3. Tighten the vise.
4. Loosen the work stop lock.
5. Slide towards the protruding end of your material until it is 1/8" from material.
6. Lock work stop down.

Basic Operation

Making a Slow Test Drop

Use the feed adjustment knob and manual feed button to do a slow test drop. Check to make sure:

1. Blade guards do not hit vise or part
2. Blade does not cut vise
3. Cut is in correct place on material
4. There is nothing obstructing the downward motion of the arm.

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Basic Cut:

1. Grab upper handle and raise the cut arm.
2. If you are going to cut at an angle, change the miter angle of the arm.
3. Insert part into the vise and clamp loosely.
4. Perform a slow drop to check measurement and clearances.
5. Clamp vise tight on material.
6. Lift blade 2 to 3 inches above material.
7. Set feed speed knob to 0.
8. Push the green button to turn blade on.
9. Wait until coolant starts flowing and completely covers cutting surface of the blade.
10. Check the chart (posted on the arm of the saw) for appropriate motor speed for your material and adjust the motor speed while the blade is running.
11. Check the chart (posted on the arm of the saw) for appropriate feed (drop) speed and turn knob slightly below chart setting to initiate cut.
12. As the blade enters the material, increase feed to appropriate chart number.
13. Keep your hand near emergency stop button and watch entire cut.
14. Wait for the blade to stop itself as it finishes cutting through your part.
15. Pull handle up and remove your material from the vise.
16. Discard large scraps, vacuum chips and coolant from machine and surrounding floor area.
17. When you finish using the Band Saw, use the feed knob and manual feed button to drop the saw to resting position.

Notes

- Lightly hold your part with your hand to prevent it from falling when cut finishes. Only do this if the length protruding from the vise exceeds six inches.
- For clamping round stock use V blocks. If cutting a large tube, you can clamp the inside of the tube to back jaw in addition to mild clamping.
- If you are cutting too fast (speed too high) you will get tightly curled DISCOLORED chips. If you are feeding too slowly, you will get powdery chips.
- Always re-lock both miter locks after you have changed the cut angle. This ensures your angle does not shift during cutting.

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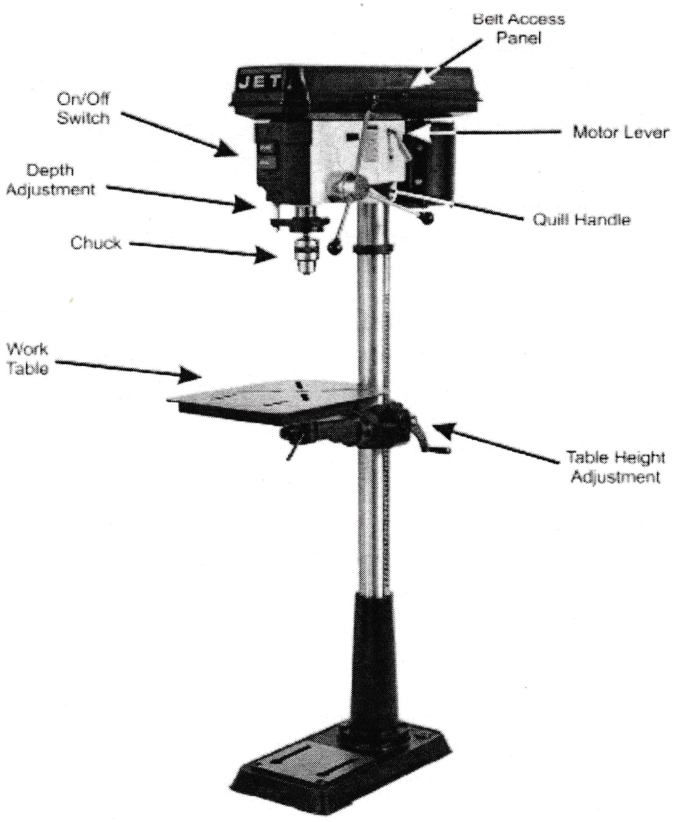
Drill Press

A drill press is a spindle mounted on a post with a height-adjustable table below it. You can adjust the speed by either changing belts (manual) or with a speed adjustment knob if it has a variable speed drive. The chuck can hold drill bits, hole saws and sanding drums.



Safety Precautions and Features

- Don't leave the key in the chuck. It will go flying across the room if you forget and could seriously injure you or someone else nearby. (Some chucks at TechShop are keyless and this does not apply)
- The drill press has a high torque spinning bit which can catch and pull loose hair or clothing into the machine causing serious injury for user. Please make sure that your body and your work area are free of anything that could get pulled into or thrown by the drill press
- Take time to prepare for adequate workholding. The spinning tool can pick up and launch poorly clamped material. Always hold material securely. The larger the bit, the more secure the work needs to be clamped
- Always grip the drill bit with the jaws of the chuck as close to the flutes (spirals) of the drill bit as possible. Do not insert the flutes into the chuck – the chuck will grab off-center and damage the flutes.
- Use the right cutting speed for the material and drill size (see chart on following page)
- If the drill binds, shut the motor off, and spin the chuck backwards by hand to work the bit out

Adjustments

Changing Belts

1. To change speeds on a manual (as compared to variable speed) drill press you must physically change the belts between different sized pulleys that convert motor rotations into specific speeds.
2. Unplug the machine when you are about to change belts. This is a dangerous area to have your hands and serious injury can occur.
3. Open the belt access panel to see current belt arrangement.
4. Loosen lock screw on both sides of the machine.

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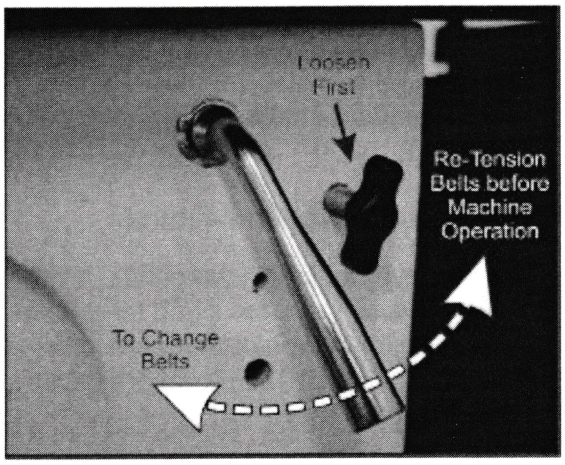
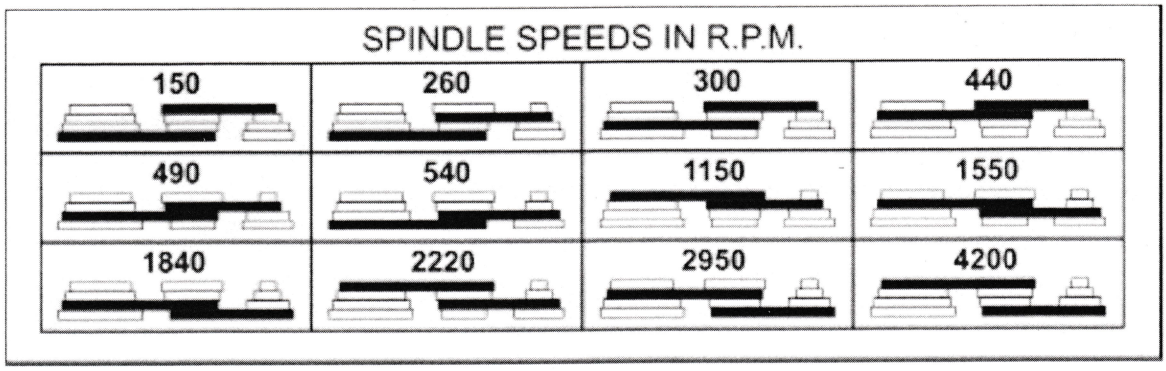
5. Pull the motor lever forward to slide motor and release tension on belts to allow adjustment.
6. Calculate your speed for your material and your bit using and the drill speed chart.
7. Match your speed to the closest speed found on the chart (see below and on the inside of the belt access panel). Always drill at a slower speed than the MAXIMUM speed indicated on the chart below or the indicated speed for the material being cut.
8. Remove belts and re position them correctly according to the arrangement on the chart for desired speed. If you are uncertain about this step please consult a TechShop facilities staff member.
9. Push the motor lever backwards to re-tension belts.
10. Tighten lock screws to lock the motor in place.
11. Close belt access panel.
12. Replug the drill press.



DRILL SPEED CHART

	Drill Bit Sizes			
Material	*1/8*	*1/4*	*1/2*	*3/4*
Aluminum	4200	1840	1150	540
Mild Steel	1550	540	440	260
Stainless Steel	490	300	150	150

For tool bits between these sizes use the closest speed setting.



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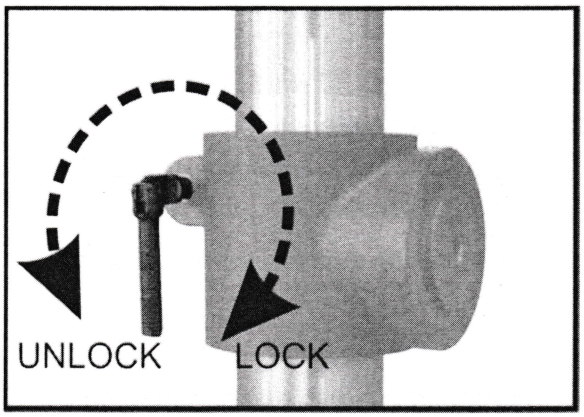
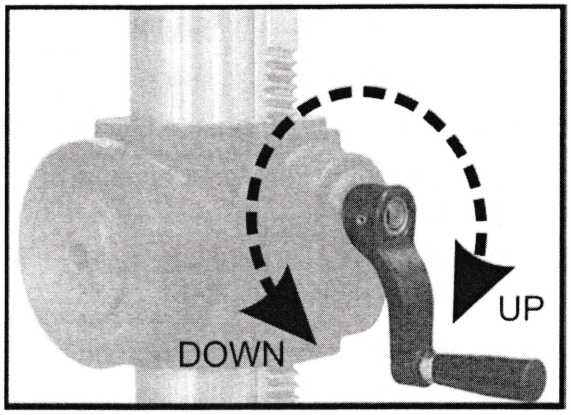
Adjusting and Locking Table Height

1. Unlock the table lock at opposite side of crank.
2. Turn crank to move the table to desired height: (leave clearance for drill bit) Material should be as close to the completely retracted drill quill as possible for maximum rigidity.
3. When the desired position is set, lock table lock.
4. DO NOT ATTEMPT TO CHANGE TABLE HEIGHT WITH THE TABLE LOCKED. it will damage the mechanism.



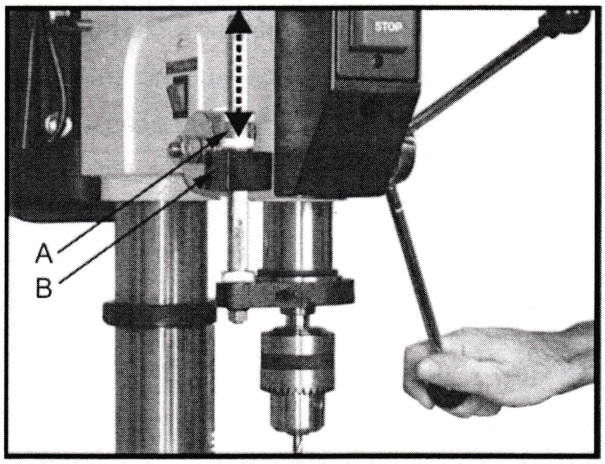


Installing a Drill Bit

1. With chuck key in hand, loosen the chuck to retract jaws to accommodate the drill bit.
2. Insert the drill bit, and hand tighten so that jaws grab the drill bit evenly close to the cutting flutes. Do not grab the flutes themselves because this will damage the bit.
3. Tighten an additional quarter to half turn with chuck key. DO NOT LET GO OF CHUCK KEY! ALWAYS KEEP IT IN YOUR HAND.

Setting the Depth Stop

1. Insert drill bit into chuck.
2. Using the quill handle, lower the drill bit to desired depth with your right hand.
3. With your left hand reach up to the left side of the machine and screw the depth stop ring all the way down until is stops.
4. Now the quill will not plunge to a depth greater than you set.



A-Depth Stop Lock Nut B-Seat

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Basic Operation

1. Using the chart provided above, choose the appropriate speed for material and tool diameter.
2. With machine unplugged, change belts to appropriate speed.
3. Insert tool into chuck and tighten.
4. Plug machine back in.
5. Raise table to appropriate height according to material height.
6. Position material under the drill bit.
7. Use c-clamps or vise grip clamps to secure work to table.
8. Turn motor on.
9. Apply even downward pressure to quill handle and begin drilling material.
10. Spray coolant to keep your material cool and flush away chips. Do not use bare fingers to remove chips.
11. Follow through until hole is completed, then retract the drill while motor is running and return quill handle to resting position.
12. Turn off motor.
13. Unclamp material, and vacuum or clean chips with short handle brush and dust pan and dispose of scrap in scrap bin.

Notes

- It is possible to grab bits off-center – especially with small bits. Always check to see that your drill is centered in the chuck. Spin the chuck one full revolution by hand before turning it on, to make sure it's set up correctly.
- Ease up on the down pressure as you break through your material.
- Check sharpness of the drill bit. If it smokes or screeches, it's dull and you should sharpen or replace it. If you see rainbows on the steel of your bit, it's been overheated. Replace it.
- When drilling deep holes, pull the drill out of the hole every few seconds to release the chips
- Make sure there is nothing unnecessary in the belt panel after you change belts. Don't leave anything in there.
- Make sure the belt lid is closed to prevent injury should either belt break.

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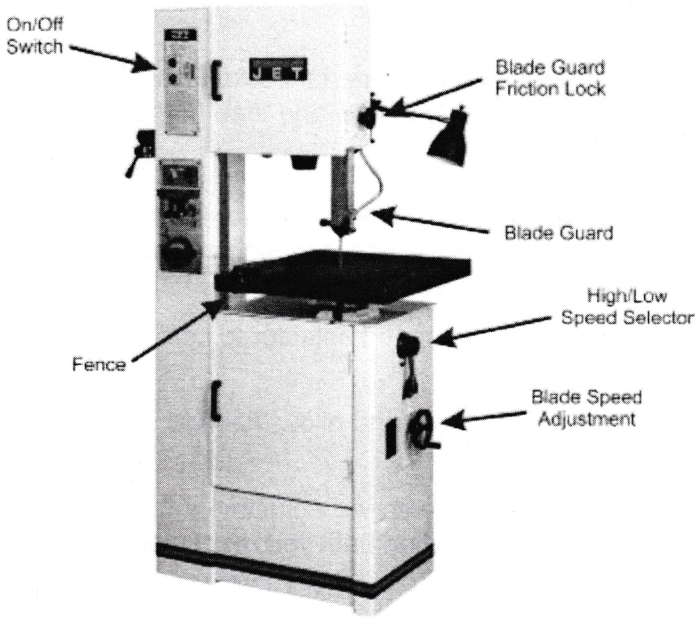
The Vertical Band Saw



The vertical Band Saw is versatile and can make either straight or curved cuts in your material. It consists of a pair of large wheels, with a seamless steel saw blade wrapped around them.

Long straight cuts are not as precise as those possible with the horizontal Band Saw or cold saw. The thicker the material gets, the less accurate the cut will be. With that in mind, the vertical Band Saw is best used for curved cuts that cannot be done with a horizontal Band Saw or cold saw.

Safety Precautions and Features

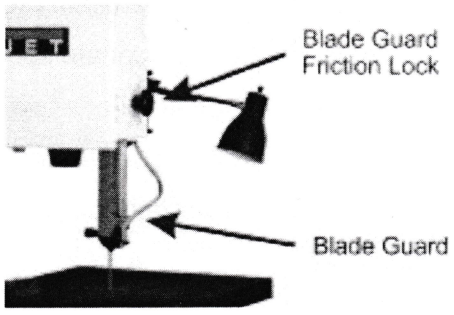
The blade of the vertical Band Saw moves rapidly. Being aware of the following cautionary points will help you cut safely.

- Keep hands out of the path of the blade at all times when making cuts
- Do not apply excess force when feeding material into the blade
- Always apply adequate downward force on your material while cutting to minimize chatter (vibration) which damages the blade
- Use the correct blade speed for the material being cut
- Do not remove scraps around your material while the motor is on and the blade is moving
- Do not lean on work being cut. Stand close and slowly straighten arms to feed work

Adjustments

Blade guard height adjustment

Blade Guard Height - This is the primary adjustment made for every cut.



1. Loosen the guard by releasing the blade guard friction lock on the side of the upper housing of the saw, directly above the guard.
2. Manually adjust the guard so that it sits 1/8" to 1/4" above your material.
3. Re-tighten the blade guard friction lock

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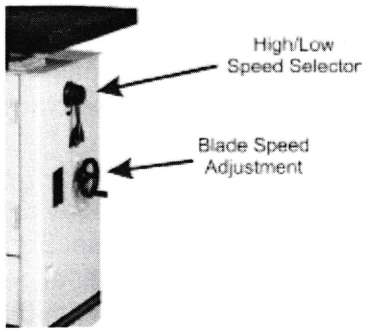
Gear and Speed Change

Different materials and material thickness will necessitate changing gears between high and low, and then further changing speeds within those ranges.

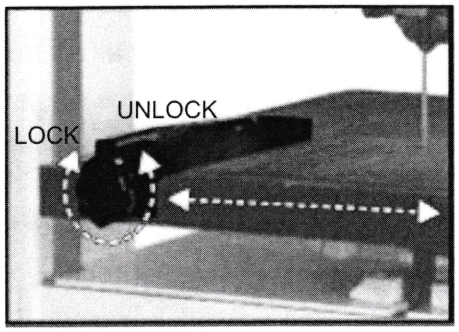


1. Determine appropriate speed for the metal you are using. Determine whether this is in high or low gear and what blade speed is appropriate.
2. Move high/low speed selector to correct gear setting for your material.
3. Turn machine on, and allow blade to speed up to its maximum velocity.
4. Rotate the blade speed adjustment crank handle in the appropriate direction until you reach your desired speed.

- ONLY CHANGE **GEARS** WHEN THE SAW IS **OFF**.
- ONLY CHANGE **SPEEDS** WHEN THE SAW IS **ON**.

Fence Adjustment

The fence allows you to have a steady guide to move your material against to make an accurate dimensioned cut.



To adjust the fence:

1. Loosen the friction lock knob.
2. Measure appropriate distance from blade for cut using a tape measure or combination square off of the saw blade.
3. Slide the fence to this location.
4. Re-tighten the friction lock knob.

Basic Operation

1. Set appropriate blade guard height for your material.
2. If using the fence, set an appropriate distance from the blade for cutting your material.
3. Determine the appropriate speed and gear setting for your material.
4. Set the appropriate gear while machine is not running.
5. Set the appropriate speed while machine is running.
6. Slowly bring your part into contact with the blade while maintaining adequate downward pressure.
7. Keep your hands out of the path of the blade and push your cut all the way through.
8. When finished with your cut turn off the motor and allow the blade to come to a stop.
9. Remove all scraps around your cut and clean chips off of the table and surrounding floor area.

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Notes

- For plastics, use high gear and cut using moderate to high speed
- If the blade starts getting stuck in your material or slowing down you are making too aggressive of a cut or your material is too thick or too hard. Do not lean on work while cutting. Contact a TechShop facilities staff member for assistance
- **Stainless steel and hardened steel can not be cut on this machine** use the abrasive chop saw. When using the abrasive chop saw your material can become work hardened. If your material does work harden it will not cut. Do not allow the material to become red hot during cutting processes.
- Do not make too aggressive of a curve and bend the blade. This could ruin the blade and your material. The blade thickness determines the minimum radius that can be cut
- The saw takes a very long time to stop, after the power is turned off. Be aware, and keep your hands away from the blade until it is completely stopped
- Do not attempt to back out of a deep (+2") cut while the blade is running, especially a curved one. You will very likely pull the blade off the wheels
- To stop a cut in the middle of a cut, or to get the blade out of an incomplete cut, stop the motor, and wiggle the blade out backwards with the motor stopped
- Scrap material: As you cut, small bits of metal are trimmed away from your material. These can collect on the table in the area around the blade or even get stuck in the blade slot. Do NOT attempt to flick these away with your hands. Stop the blade before removing them
- Cut radius: The radius of the curve that the saw will cut is a function of the width of the blade from front to rear. The wider the blade, the larger (wider) the minimum radius it will cut, the trade-off being that it will do better with straight cuts. Narrow blades will cut a tight radius, but afford less guidance on straight cuts

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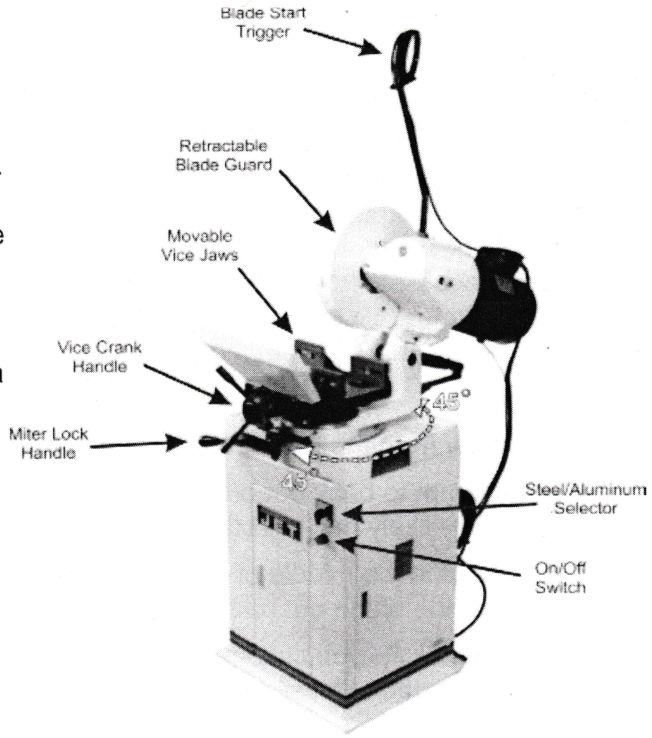
Cold Saw

The cold saw makes accurate, square and angled cuts in steel and aluminum. The saw is heavy and stable and the dual vise clamping system makes for more accurate cuts than an abrasive chop saw with minimal burring, almost like a machined edge.

It uses a solid HSS (high speed steel) circular saw blade to cut the material with the force of the user. It's a "cold saw" because it transfers the heat generated by cutting to the chips created by the saw blade. This is the opposite of an abrasive saw which abraids the metal and stores a great deal of heat in the material and the blade.



Safety Precautions and Features

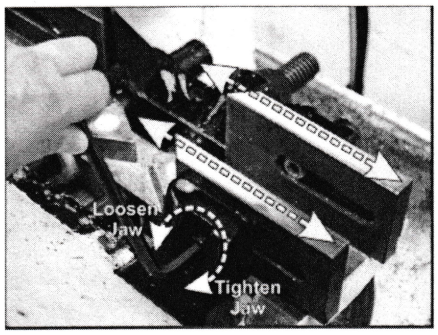
- The cold saw can handle a range of materials from aluminum to steel. However, hardened steel and stainless steel are too hard and must be cut with an abrasive chop saw. If you want to cut these materials find a TechShop facilities staff member.
- Because of the high cutting forces involved with the thick blade, the material being cut must be held correctly and tightly in the vise. If you are uncertain about your workholding, please grab a TechShop facilities staff member for assistance.
- When cutting keep both hands on the trigger handle. This ensures that your hands are not near the cutting plane and allows you to provide appropriate, constant downward pressure (feed).

Adjustments

Work holding

Work holding is one of the most important adjustments you can make to the cold saw because of the high cutting forces involved. The four jaws of the vise are locked together and work like a normal vise except that there is support on both sides of the blade for your material which greatly increases rigidity.

- Clamp work very tightly in the vise using the vise handle
- Refer to the beginning of this handout for workholding techniques
- The jaws of the vise can be loosened with the allen wrench on the side of the machine and moved left and right along your material to accommodate the saw blade
- IN NORMAL STRAIGHT CUTS the vise jaws should have a 1/8" clearance on either side of the blade to allow safe blade passage and also to have better grip on your part.
- Always make sure to re-tighten your vise jaws after adjusting.



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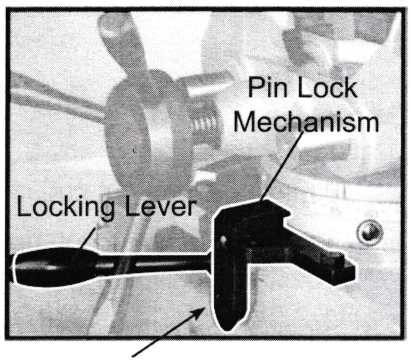
Miter (Angle) Cuts

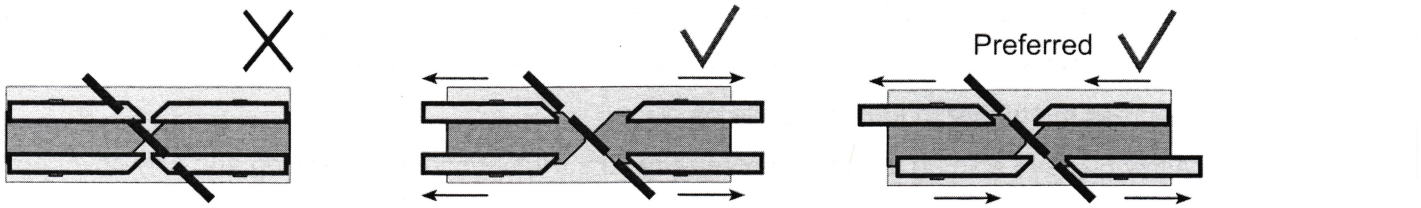
The cold saw upper assembly is capable of being rotated to make angled cuts up to 45° degrees in your material in both directions. It is important to always test whether or not the blade will hit the vise jaws and adjust the jaws according to your angle.

Changing Angle of Cut

1. Loosen the locking lever by moving it to the left
2. Push in lock mechanism to release it from pin
3. Pull the back of the saw to set desired angle for your cut.
4. There is a fixed stop pin at 45°. If you are cutting a 45° angle, release the lock mechanism near 45° and allow it to lock.
5. If you are cutting angles aside from 45°, stop at your desired position and retighten the locking lever by moving it to the right.



Push here to release pin lock



Adjust the Vise Jaws

1. Remove the allen wrench from left side of the machine and loosen the bolts on appropriate jaws.
2. Move jaws out of blade path.
3. With the saw turned OFF, bring the blade down with jaws in new position to check for clearance.
4. If blade is clear of jaws, re-tighten jaws and replace allen wrench in the slot on left side of machine.

Work Stop Adjustment

The work stop is a mechanical stop that can be locked at a specific distance from the vise to allow you to quickly cut many parts of the same length without having to measure every time you cut.

1. Hold part loosely in the vise and slowly drop blade to 1/2" above material.
2. Measure and move material until correct cut length is achieved.
3. Tighten work holding vise.
4. Loosen the work stop lock.
5. Slide work stop towards protruding end of your material until it is 1/8" from material.
6. Lock work stop down.

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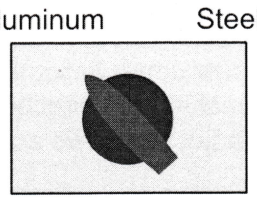
Set Speed Appropriately for Material

You will have to adjust the blade speed appropriately for the material you are cutting. This saw has two speeds: steel and aluminum. Make sure this is set appropriately



Basic Operation

1. If making a straight cut, check that the locking pin is engaged and the saw is locked correctly.
2. If making an angle cut, unlock the miter locking lever, release the locking mechanism and move to desired position and then relock the miter locking lever.
3. Slowly drop the saw without turning on the blade to check vise jaw clearance.
4. Adjust the vise jaws appropriately to allow clearance.
5. Clamp material tightly in the vise. Use appropriate workholding for geometry of your material.
6. Turn on the machine using the switch on the front.
7. Switch between aluminum or steel. Do not do this when the blade is running.
8. Depress the trigger to turn the blade on.
9. Allow blade to spin up to maximum velocity. Ensure that coolant is flowing and fully covering the cutting surface of the blade. DRY CUTTING will break the blade. This is considered to be tool abuse and you could be held responsible for replacing the $200 dollar blade.
10. With BOTH hands on trigger. Evenly apply downward pressure and begin cutting material.
11. Continue applying steady, downward force and FOLLOW THROUGH until saw reaches end of travel. The blade travel stops before the saw reaches the bed of the vise so do not attempt to stop cut prematurely.
12. Once cut is complete, release trigger and return saw to upper position.
13. Unclamp material and remove scraps.
14. If you made any angle adjustments return the saw to 0° and RE-ADJUST THE Vise JAWS. Also ensure that the locking pin is in place and the miter locking lever is locked.

Notes

- Saw will make a loud grinding noise. This is the nature of this machine. If you do not feel like you are removing material at a rapid rate you are probably cutting the wrong material
- Both hands on the handle and slightly lean into the saw. The weight of your body alone with a little force is enough to cut. DO NOT ATTEMPT TO FORCE THE CUT
- IF YOU SEE THE BLADE SKIPPING YOU ARE APPLYING TOO MUCH FORCE.
- DRY CUTTING will break the blade. This is considered to be “abuse of tools” and you could be held responsible for replacing the $200 dollar blade

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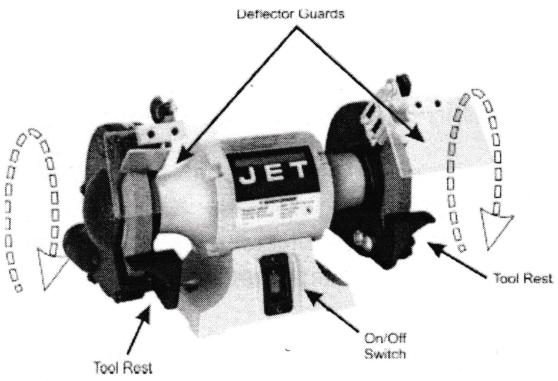
Grinder

The grinder is an abrasive wheel that uses a rough stone to wear away harder metals. It can shape the metal, remove burrs and clean up rough cut edges.

Because of the soft nature of aluminum and brass they cannot be ground on this machine.



Safety Precautions and Features

The rapidly spinning disks on the grinder are capable of causing serious injury. They are also more fragile than one initially thinks because of the vibration associated with the high speeds. Keep these safety precautions in mind at all times.

- DO NOT GRIND ALUMINUM OR BRASS ON A GRINDER. Grinding aluminum and brass adds extra material to the wheel, which can cause it to rotate irregularly and shatter resulting in serious injury
- Always keep material seated against the tool rest. If you hold it free hand you, can lose control of your material due to the strong downward forces. Hold material with vise grips if necessary.
- Ensure that the gap between the tool rest and the wheel is 1/8" or less. The downward motion of the wheel can pull your part in and shatter the wheel or launch the part causing serious injury if this gap is too big
- Hold the material firmly, and take light, steady passes against the wheel
- Do not feed part into wheel aggressively. Initial contact with the wheel should be slow and constant
- Keep spark shield down at all time
- Visually inspect wheels before starting the motor for uneven surfaces, chips or knicks, and any residual material stuck in the surface of the wheel
- Stand aside as the motor comes up to speed
- Do not wear gloves when using this machine. They could pull your hand into the wheel
- Do not grind on the side of the wheel. Always use the front face of the wheel

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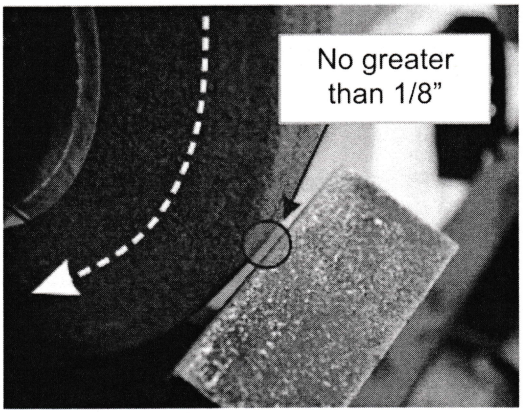
Adjustments

Adjusting Tool Rest Distance and Angle

The tool rest is used to stabilize your part as you grind. The majority of grinding operations should be done with your part touching the tool rest for stability against the downward force of the spinning wheel.



It is important that the distance between the table and the grinding wheel is no greater than 1/8” because the force of the spinning wheel will pull your material into the gap. This could cause the wheel to jam and possibly shatter at a high speed. Always turn grinder OFF before making any adjustments.

When to adjust:

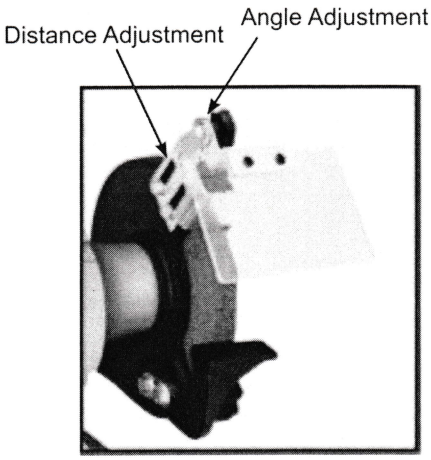
- You should adjust the tool rest if you find it and the gap is larger than 1/8”.
- You can also adjust the tool rest to change the angle at which you are grinding.

How to adjust:

1. Loosen the bolts on the interior side of the wheel cover housing.
2. Position the rest appropriately, making sure that it does not touch the wheel.
3. Spin wheel by hand to make sure it does not hit the rest.

Adjusting Deflector Guard Angle

The deflector guard shields you from sparks and particles thrown during the grinding process.



- To adjust the distance of the guard from the wheel loosen the bolts on the interior side of the wheel housing.
- To adjust the angle of the deflector guard loosen the friction lock at the top of the guard assembly. Retighten after adjusting

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Basic Operation

1. Turn the motor on, and allow the wheel to spin up to its maximum velocity while standing clear to the side of the machine.
2. Firmly hold your workpiece – use vise grips if needed – on or just above the rest.
3. Push the work slowly into the wheel.
4. Keep the work moving so as not to wear out one spot on the wheel.
5. Grind with a light hand and frequently cool material in water.
6. When finished grinding move material away from wheel surface.
7. Turn motor off and allow to it to spin to a stop.
8. Clean up work and surrounding floor area.
9. Remove all scraps from your cut, and clean chips from table and surrounding floor area.

Notes

- Your workpiece will get hot enough to change the temper and heat treat the metal if you do not take light passes and frequently pull the metal away from the wheel to cool. You can use a cup of water to douse your part to quickly cool it.
- If the wheels do have excess material in them or have an irregular surface ask a TechShop facilities staff member to Dress them for you.
- When grinding stainless, do NOT allow it to get red hot. This will make it too hard for further work

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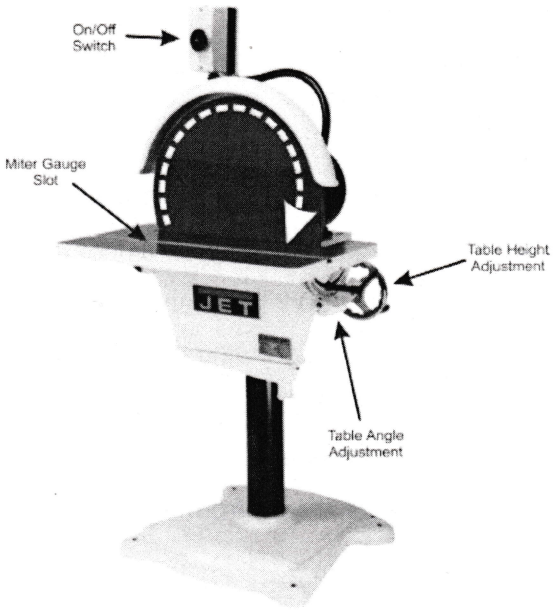
Disk Sander



The disck sander consists of an electric motor on which an adhesive disk of sandpaper is mounted. It is used to sand and shape metals.

Below both the belt and disk section of this tool is a table which acts as a solid surface on which to place your part as sanding operations are performed. Both of these tables can be set to specific angles for specific needs. These tables also have a machined slot which is meant for a miter gauge to fit into. This slot will hold the miter gauge securely. The miter gauge allows for a large degree of angle adjustment upon the table surface.

Safety Precautions and Features

- Always hold the part securely against the table. Do not hold the part while hovering above the table
- Do not start the tool with a part making contact with the abrasive surface of the belt or disk. Only touch part after the disk has reached maximum speed
- Be aware of the clockwise direction of travel of the disk
- Keep hands back and away from the abrasive surfaces
- When rounding edges and full contact cannot be made with the table, make sure to at least use the table as the pivot point
- Avoid letting thin materials slide between the table and the wheel. the force of the wheel can potentially tear the material out of your hands and cause serious injury

Adjustments

Adjusting Table Height

- The table height has been preset by TechShop facilities for optimum usage.

Adjusting Table Angle

You can change the angle at which you grind your material to make beveled edges.

1. Unlock the table tilt lock.
2. Turn the table tilt handle until the table reaches the desired angle.
3. Lock the table tilt.

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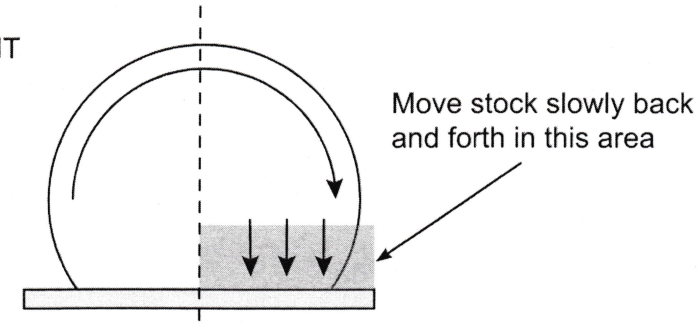
Basic Operation

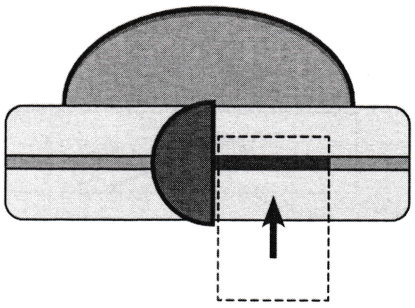
1. Visually inspect the disk for excessive wear or torn sand paper.
2. Visually inspect the area around the disk to make sure nothing is contacting it.
3. Turn disk on and allow it to reach maximum .
4. Slowly and with constant pressure move the material back and forth ON THE RIGHT HALF of the grinding wheel. Staying in one place too long wears grooves in the sanding disk.

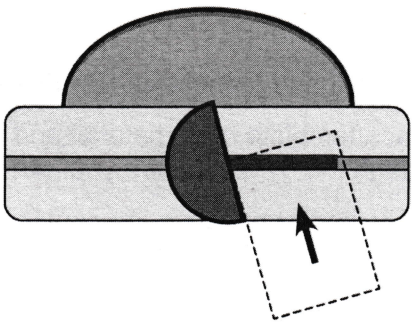


5. When finished remove material from the wheel.
6. Turn off the motor and allow the wheel to spin to a stop. It takes several minutes for the disk to come to a complete stop. This is one of the few machines that you can walk away from when its spinning.
7. Clean up work and surrounding area once the disk has come to a complete stop.

Notes

- You can use a miter gauge for support and to change the angle you grind your material at.
- A miter gauge is also useful to make sure you are grinding square edges. The disk can sand your material quicker than you can anticipate and lead to unintentionally angled edges. Set the guage at 90°





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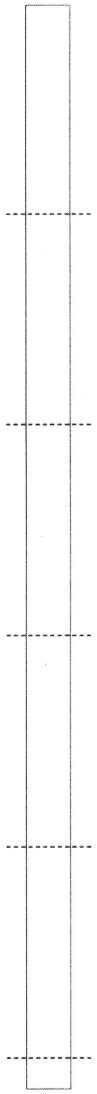
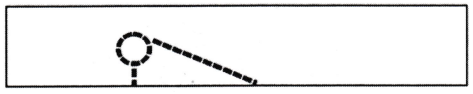
Project Workflow

Machine 1: Horizontal Band Saw



1. Raise the blade arm to a height that allows you to have room to place and secure your part.
2. Place 25" piece of material in the vise.
3. Using the manual feed button bring the blade down to just above the material and setup a 8" cut by measuring from blade to end of material.
4. Close the vise tightly by turning the handle clockwise.
5. Loosen the work stop and re-tighten it against end of material so multiple 8" cuts can be made.
6. Turn the feed knob to 0.
7. Release the power switch on the control panel by turning the red switch button to the right and turn the blade on by depressing the green button with the saw blade graphic above it.
8. With the blade running, turn the motor speed adjustment knob until the motor speed reads 165 for steel or 350 for aluminum.
9. Turn the blade OFF.
10. Ensure that blade guides will not collide with the vise or the material (Adjust if necessary).
11. Turn the blade ON, set the feed speed for your material and make the cut.
12. When the blade stops, raise the arm, loosen the vise, and move material until it hits the work stop.
13. Re-tighten the vise and make the next cut(s).
14. Turn the horizontal Band Saw OFF by depressing the red button.

Layout



1. Coat surface of material with Dykem and let dry.
2. Place template over material and use a scribe to etch through the dykem to see your cut lines.
3. Place center punch in the center of the hole to be drilled and hit it with a hammer.

Machine 3: Drill Press

1. To loosen tension on the belts in order to change the speed loosen the screw behind the motor lever and pull the motor lever towards the front of the machine.
2. Using the chart under the lid of the belt access panel arrange the belts to set a speed of 440 RPM for steel or 1150 RPM for aluminum.
3. Close the belt access panel and push the motor lever to the back of the machine and tighten the screw behind the motor lever.

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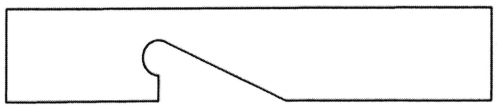
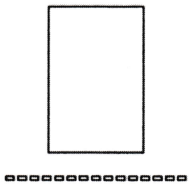
4. Select a 1/2" drill bit and place it into the jaws of the chuck and hand tighten.
5. Using the chuck key tighten the chuck a 1/4 turn beyond hand tight.
6. Secure work piece to the table surface using C-clamps.
7. Unlock the table and move it to an appropriate height for drilling.
8. Align desired hole location with the drill bit.
9. Turn the drill press on and wait for the bit to reach maximum velocity.
10. Using the quill handle push the drill bit into the work piece until the hole is completed.
11. Turn the drill press OFF.

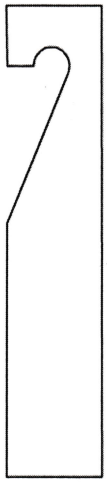
Machine 4: Vertical Band Saw



1. With the machine OFF, move the High/Low Speed Selector towards the front of the machine to select low speed for steel or high speed for aluminum.
2. Turn the blade guard height crank in the appropriate direction until the guard is 1/8" to 1/4" above the material.
3. Turn the blade ON and turn the blade speed handle until the blade speed reads 150 SFM (Surface Feet Minute) for steel or 1500 SFM for aluminum.
4. Slowly and evenly push material into the blade and turn material as needed to complete the cut.
5. Turn the vertical Band Saw blade OFF.

Machine 2: Cold Saw





1. Open the vise and place a 8" piece of material flat in the vise.
2. Loosen jaws and move towards center if not getting a secure grip on the material (make sure that the jaws are out of the way of the blade path before starting cut).
3. Pull the blade down to just above the material and setup a 2" cut by measuring from blade to end of material.
4. Close the vise tightly by turning the handle clockwise.
5. Turn the saw speed knob to appropriate setting for your material and turn the power ON.
6. Depress trigger to turn blade ON. Wait for blade to spin up to its maximum speed.
7. Pull the handle downwards and slowly and evenly apply downward pressure until the material has been cut.
8. When cut is complete raise the blade, loosen the vise, and move material until it hits the work stop.
9. Re-tighten the vise and make the next cut(s).
10. Turn the cold saw OFF.

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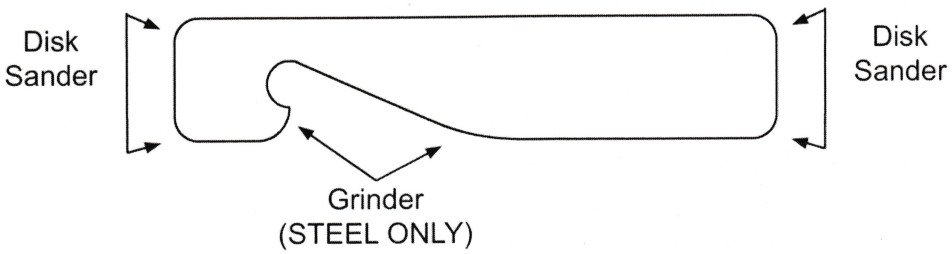
Machine 5: Grinder

1. Turn grinder ON. DO NOT GRIND ALUMINUM. GRINDER IS FOR STEEL ONLY. Use steel wheel if available or use file to round interior corners.
2. With your material away from the wheel, wait for it to spin up to its maximum speed.
3. With the material flat against the tool rest, move material gently into the path of the wheel.
4. Round the corners of the interior cuts until smooth.
5. Turn the grinder OFF.

Machine 5: Disk Sander

1. Turn the disk sander ON.
2. With your material away from the wheel, wait for it to spin up to its maximum speed.
3. With material flat against the work table, move material gently into the path of the wheel on the RIGHT SIDE OF THE WHEEL ONLY.
4. Round all four edges of the material until smooth.
5. Turn the disk sander OFF.
6. File all edges with a 8" Bastard file or use deburring tool.



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USEFUL LINKS

www.onlinemetals.com
Online store for purchasing a variety of metals in small quantities

www.thesheetmetalshop.com
Sheetmetal industry resource,tutorials,tools,classifieds

www.engineersedge.com/bend_allow_calc.htm
Sheet metal calculator bend allowance equations and calculator

www.thefabricator.com
Provides metal fabrication resources, news, and information

www.mcmaster.com
Mcmaster-Carr is a huge supplier of industrial equipment and parts from A-Z

OTHER RESOURCES

Sheet Metal Technology by David J. Gingery
Loaded with information on projects and detailed information and procedures of the sheet metal trade.

Ultimate Sheet Metal Fabrication Book by Timothy Remus
Detailed chapters cover: the right tool for the job, materials, welding, repairs, scratch building, finish work. Also includes tips on how to repair and modify an existing part and starting a part from scratch.

Sheet Metal Fabrication: Techniques and Tips for Beginners and Pros by Eddie Paul
This book talks about the necessary tools and how to use them; how to choose, prepare and work with the right material; how to make forms and mock-ups, and much more.

WHAT'S NEXT?

After successfully completing this Metal Shop SBU, you might be interested in these classes:

Metal Shop: Angular Sheet Metal SBU
Metal Shop: Organic Sheet Metal SBU
Welding: MIG Welding SBU
Welding: TIG Welding SBU
Machine Shop: Milling Machine SBU
Machine Shop: Lathe SBU

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